Swine Mortality Composting

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Chapter 1 MORTALITY COMPOSTING PRINCIPLES

Introduction

Mortalities are a fact of life for commercial livestock producers. Livestock and poultry die from disease, accidents and competition. Under Alberta's *Destruction and Disposal of Dead Animals Regulation* of the *Livestock Diseases Act* (refer to **Appendix B**), the owner of a dead animal shall dispose of the animal within 48 hours of its death. Today, animal agriculture is challenged to discover innovative ways to dispose of livestock and poultry mortality. This need has been brought on by the limited accessibility of rendering plants, concerns over burial and groundwater pollution, the economic cost and other issues related to incineration, and by the large volume of deads from larger livestock operations. Composting of livestock mortalities is one option that is now available. There are two general approaches to livestock mortality composting: enclosed or bin systems, and open pile systems. Alberta regulations allow either option for livestock composting. This section provides an overview of the principles of composting and management practices for composting animal mortalities.

Basics of Composting

Composting is a natural biological process of decomposition of organic materials in a predominantly aerobic (presence of air) environment. During this process, bacteria, fungi, and other micro-organisms break down organic materials into a stable mixture called compost, while consuming oxygen and releasing heat, water, and carbon dioxide (CO_2). The finished compost resembles humus and can be used as a soil amendment. Composting reduces the volume of the parent materials, and pathogens are destroyed if the process is controlled properly.

Micro-organisms involved in composting can be classified according to temperatures most favourable to their metabolism and growth. The mesophilic 10 - 43°C (50 - 110°F) and thermophilic micro-organism 43 - 71°C (110 - 160°F) are the principal groups. A simplified view of the composting process is presented in ***Figure 1.***

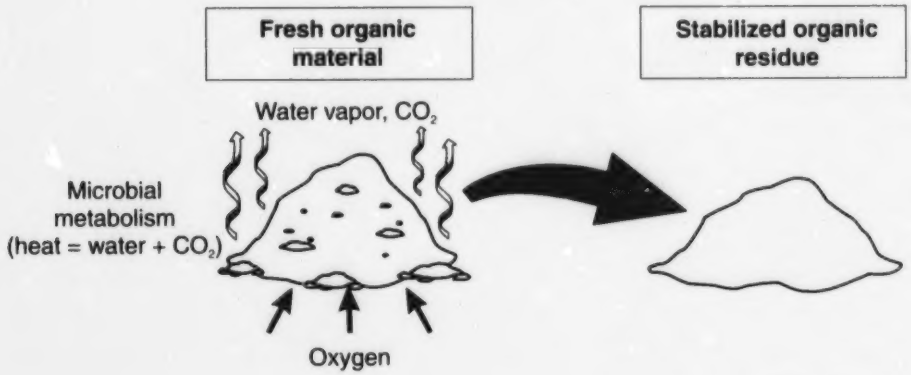


Figure 1. Composting process.

Under controlled conditions, composting is accomplished in two main stages: a composting stage and a curing stage (see ***Figure 2***). The composting stage involves three sub-stages:

- An initial stage (lasting one to three days) when mesophilic micro-organisms degrade constituents such as sugars, starch and proteins and compost temperatures rise rapidly.
- A high rate thermophilic stage (lasting 10 to 100 days) in which temperatures rise above 41°C (110°F) and fats, hemicellulose, cellulose and some lignins are degraded and pathogens are destroyed.
- A stabilization stage (lasting 10 to 100 days) during which time the temperature declines and further degradation of cellulose, hemicellulose and lignins occurs.

The high-rate stage is accomplished through a high rate of oxygen uptake and carbon dioxide (CO_2) output. Ammonia (NH_3) and other gases may be released if the process is not controlled well. During curing or maturation, mesophilic organisms recolonize the compost. The length of curing time depends on market opportunities but typically represents a minimum of one month and generally lasts three to six months.

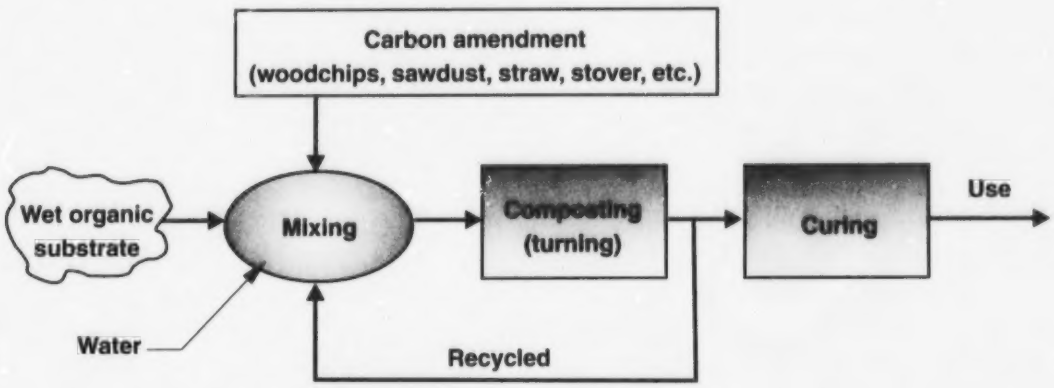


Figure 2. Material flow for the conventional composting process.

Factors Affecting Composting

While composting is a natural process, it requires proper conditions to occur rapidly, minimize odour generation, and prevent nuisance problems. Over twenty controllable factors affect composting. **Table 1** lists eight of these factors and acceptable ranges to aim for when composting. Four major factors to be controlled in the composting process are the material mix (nutrient balance), water content, porosity, and temperature.

Material Mix (C:N)

The proper compost mix requires both carbon and nitrogen at the proper C:N ratio. This will result in a composting process that generates little odour, yet offers an environment where micro-organisms can flourish. Generally, an initial C:N ratio ranging from 20:1 to 40:1 is satisfactory. Most compostable materials have a C:N ratio that is too low to compost properly on their own. In order to compost these materials, amendments that contain a

high C:N ratio must be added. Plant materials such as wood chips, sawdust, chopped corn stover, shredded paper, or straw have a high C:N ratio for on-farm composting.

Water Content and Porosity

Like all living things, micro-organisms need water. To encourage their growth and rapid composting, water content of the mixture should be 50 - 60% (wet basis). It is important to avoid excess water due to the potential for odour and leachate conditions. If the mixture feels moist, yet no water drips from it when a handful is squeezed, the mixture probably has adequate water content.

Micro-organisms that are encouraged to grow in a compost pile are aerobic, or require oxygen. Open spaces (porosity) must be maintained to allow air to penetrate and move through the pile providing oxygen. Ideally, 35 - 45% of the pile volume should be small, open spaces. Optimum porosity is achieved by balancing the material's particle sizes, water content of the mix, and pile size.

Temperature

The composting process will generate and regulate its own temperature. However, to maintain high temperatures the pile must be large or have some insulation. A layer of inactive material, sawdust, or finished compost placed over the entire pile will insulate the pile. As the pile heats up, warm air within the mixture will rise and move out of the pile, while fresh air will be drawn in to replace it. This process exhausts the CO_2 created in the pile and maintains an aerobic environment for the micro-organisms.

The highest rates of decomposition occur for temperatures in the range of 43 - 66°C (110 -150°F). Also, high temperatures above 55°C (131°F), over three days, will kill parasites, and fecal and plant pathogens within the pile. At temperatures above 66°C (150°F), microbial activity declines rapidly with activity approaching low values as compost temperature exceeds 71°C (160°F).

Table 1. Guidelines for composting: major factors.

Major Factors	Reasonable Range	Preferred Range
Nutrient Balance (C:N ratio)	20:1 - 40:1	30:1 - 35:1
Water Content	45 - 65% w.b.	50 - 60% w.b.
Particle Size	0.8 - 1.2 cm (1/8 - 1/2")	Depends on Material
Porosity	30 - 50%	35 - 45%
Bulk Density	< 640 kg/m^3 (1100 lb/yd^3)	
pH	5.8 - 9.0	6.5 - 8.0
Oxygen Concentration	> 5%	> 10%
Temperature	45 - 68°C (113 - 155°F)	54 - 66°C (130 - 150°F)

Livestock Mortality Composting

Composting livestock mortality almost always moves toward satisfying the principles previously mentioned. Unfortunately, strict application of these standards should only be done when dealing with a consistent, thoroughly mixed pile. The reality is that a pile in which livestock mortality is composted is an inconsistent mixture. Therefore, composting livestock mortality must be approached in a slightly different way.

Figure 3 illustrates the process followed for composting animal mortality. The compost pile (either open or in a bin) is an inconsistent mixture. It is composed of a large mass of material (the animal) with a low C:N ratio, a high moisture content, and nearly zero porosity surrounded by a material (the carbon amendment) with a high C:N ratio, moderate moisture levels, and good porosity. The animal and amendments are layered into the pile. No mixing is done until after the high-rate stage of composting has occurred and the animal has fully decomposed. Composting livestock mortalities (primary stage) can best be described as *"above ground burial in a bio-mass filter with pathogen kill by high temperature"*.

The decomposition process is anaerobic (lacking oxygen) in and around the animal mortality, but as gases are produced and diffused away from the mortality, they enter an aerobic zone. Here the gases are trapped in the surrounding material, ingested by the micro-organisms, and degraded to CO_2 and H_2O. The surrounding material supports bacteria to form a biological filter, or a biofilter.

With this scenario, avoid turning the pile until the mortality has been decomposed. For moderately sized animals (poultry, pigs, sheep, etc.) this is generally less than three months after the last mortality has been placed into the pile. After this time, the pile is moved to a secondary area where it is allowed to compost for an additional 10 days to several months. This procedure introduces air back into the pile and mixes the contents, leading to more uniformity in the finished compost. The secondary pile is then turned and placed in a pile for storage for 30 days or more. When composting large, mature animals, bones sometimes remain intact after completion of the secondary/storage process. They are generally quite brittle and pose no health risks or danger to equipment when land applied. In some instances, it may be desirable to recycle the larger bones back into the compost to allow for more decomposition.

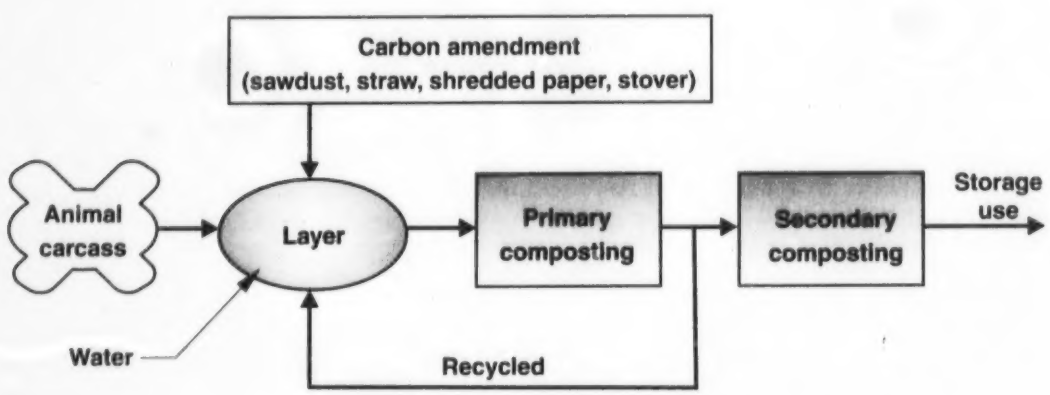


Figure 3. Material flow in livestock mortality composting.

Chapter 2 PLANNING CONSIDERATIONS

Construction

Actual construction of a composter can be of many different forms, all producing good results. Some essential features to consider are location, type of structure, construction materials, and ingredient storage. All good composters will include some or all of the following characteristics.

Location/Access

Location of a composter should follow the criteria in Section 2, subsection (4)(d)(ii) of the *Destruction and Disposal of Dead Animals (A.R. 229/2000)* of the *Livestock Diseases Act.* It states that the compost pile be:

- at least 100 metres from wells or other domestic water intakes, streams, creeks, ponds, springs, and high water marks of lakes and at least 25 metres from the edge of a coulee, major cut or embankment.
- at least 100 metres from any residences.
- at least 100 metres from any livestock facilities, including pastures, situated on land owned or leased by another person.

The location should also take into account any impact it may have on the farm residence and any nearby neighbouring residences. While offensive odours are not usually generated in the composting process, the handling of dead pigs, manure, and litter on a daily basis may not be aesthetically pleasing. When locating a composter consideration should be given to traffic patterns required for moving dead pigs, the required ingredients, and removing the finished compost from the composter. The composter site should be well-drained and provide all-weather access roads and work areas.

Foundation/Floor

An impervious, weight-bearing foundation and floor should be provided for all primary and secondary composting areas. This feature ensures all-weather operation, helps secure the composter against rodent access, and generally minimizes the potential for contamination of the surrounding area. In addition to providing concrete under the compost bins, consideration should also be given to providing a similar concrete floor in traffic areas and work alleys. Experience has shown that with the frequent loading and unloading activities associated with composting, dirt or even gravel areas tend to become rutted and potholed. This condition worsens if the work alleys are not roofed.

Construction Materials

Any portion of the composter structure such as poles and sidewalls that will be in contact with dirt or composting material should be constructed with pressure treated lumber or other rot-resistant materials.

Roof

A roof covering the primary and secondary composting bins is required to control rainwater and the moisture content of the composting mass. Roofing the working area also facilitates all-weather activities. Additionally, any ingredient storage areas or bins should be roofed to preserve the ingredients at the desired moisture content. Roof heights must be adequate to ensure clearance for front-end loaders. However, a high roof may allow too much direct rain or water draining off the roof to be blown into the composter. This problem can be minimized by adding partial sidewalls and roof gutters.

Ingredient Storage

Having sufficient amounts of ingredients such as sawdust and litter present at the composter site greatly facilitate the day-to-day management of the process. However, litter may only be readily available from solid manure livestock facilities such as bedded swine barns, some poultry and dairy operations, or from beef feedlots. As a result, litter supplies may be intermittent. Inclement weather can also hamper the handling and transfer of ingredients in a timely fashion. In determining the amount of storage needed consideration should be given to the frequency with which ingredient transfer and restocking can be managed. Storage requirements may vary considerably among different operations. It has been suggested that providing a minimum of two bins (of primary bin size) for ingredient storage will sufficiently facilitate the operation of a four primary bin composter. If more than four primary bins are required, ingredient storage may need to be increased according to the above ratio. Bins used for storage can double as primary composting bins (e.g., during periods of high death loss) or they may facilitate the expansion of the composter if the farm is increased. Ingredient storage does not have to be in bins but the ingredient storage area should be roofed.

If the composter can be constructed in conjunction with a litter storage facility, ingredient handling may be greatly simplified. Litter will be readily available from the litter storage area and other ingredients can be stored appropriately in the same location.

Finished Compost Storage

Secondary compost bins provide a place for compost to undergo a second heating cycle and further composting. However, as secondary bins become full the compost must either be spread on the land or moved to a finished compost storage area. Any compost storage area should be covered to prevent rainfall from saturating the pile which could cause leaching. A litter storage facility can also be used to store finished compost until land spreading can be conveniently carried out.

Utilities

A water line with a freeze-proof hydrant at the composting facility will aid in adjusting the moisture content of the recipe (if needed) and further facilitate cleanup and washdown of personnel, equipment, and the composting area. A minimum 20-amp electrical circuit will allow for the use of power tools, lights, or other appliances that may be required at the compost facility.

Sizing the Composter

To size a swine composter, it is necessary to know or estimate the number and weight of average daily mortalities expected. Actual past death loss data should be used in sizing composters for existing operations. For new operations, having no history of average death loss, see the data in **Table 2**. Once the average daily mortality weight is known, the number and size of composters can be calculated. **Appendix A** contains worksheets for calculating average daily death loss, sawdust requirements, bin size and windrow dimensions.

It is important to size the composting facility properly. Inadequate facilities will force the compost through the operation before the process is complete, contributing to problems with odour and flies.

Bin systems constructed for composting swine typically require about 2.5 m^3 (88 ft^3) of total bin volume for each kilogram of average daily loss. Of this, 1.25 m^3 (44 ft^3) is required for primary composting, and 1.25 m^3 (44 ft^3) for secondary composting. For example, a farrow to finish farm averaging 50 kg (110 lb) of loss each day would need approximately 62.5 m^3 (2207 ft^3) of primary capacity and the same amount for secondary bin space.

Table 2. Average annual death loss for swine in confinement.

Type	Average Death Loss (%)	Average Weight per Animal (kg)	Cycle Length (days)	Expected Daily Mortality Weight (kg)
Mature Sows/Boars	5.5	200	365	4.5
Pre-weaning	19.0	2	21	2.6
Weaners	2.6	13	49	1.9
Growers	2.7	45	49	6.5
Finishers	3.0	88	49	13.7

Chapter 3 SWINE MORTALITY COMPOSTER DESIGN

The design and layout of the composter can be determined once an estimate of the primary and secondary composting volumes have been calculated. There are two basic composting designs that can be used for swine mortalities. Composting bins can be constructed to house the mortalities during the composting process, or windrows can be built with the mortalities to compost. Bin composter design is recommended for primary composting in Alberta. Scavengers and surface water can be a problem if composting mortalities in windrows.

Bin Composter Design

Bin composting masks the composting process from the public which can produce positive public relations. The initial composting takes place in a primary bin for 90 days. The material is then moved to a secondary bin where it finishes composting during another 90 day period. The layout of a composter should be flexible. This will accommodate existing features, restrictions, traffic patterns, equipment, or other factors particular to a given operation. No specific layout is necessary or best in all cases. The following points should be taken into consideration when designing a mortality composter.

1. Provide primary and secondary composting volumes as previously calculated.

2. Surface water should be diverted away or around the compost site to eliminate contamination.

3. Depth of compost bins should not exceed 1.8 m (6 ft) so as to reduce compaction effects and the potential for spontaneous combustion. An ideal bin depth is 1.5 m (5 ft).

4. A roof is recommended to help eliminate leachate and runoff concerns. If no roof is in place, an infiltration area is needed to deal with contaminated runoff.

5. Since small carcasses are usually placed inside the primary composting bins by hand, the front of the bin should be designed so that carcasses will not have to be lifted over a five foot high door. This can be accomplished with removable dropboards that slide into a vertical channel on each side of the bin, or with doors that split horizontally.

6. The width of compost bins is usually selected to accommodate the loading/unloading equipment to be used. Tractor front-end loaders, or skid-steer loaders are typically used to load and unload bins. Bin width should be at least 300 mm (12 in) wider, but preferably 0.6 - 1 m (2 - 3 ft) wider than the bucket used for unloading, in order to prevent excessive mechanical damage to the bin or loader. If wheels on the loading/unloading equipment are wider than the bucket, the bin should be widened accordingly.

7. The length of the compost bins is generally 3 - 4.5 m (10 - 15 ft) for swine. Longer bins are more difficult to enter and exit. Composting proceeds more efficiently if the composting mass lies in a square configuration, rather than a long rectangular bin.

8. Several smaller primary composting bins work more efficiently than a few very large bins.

9. Even though calculations may indicate fewer, a minimum of two primary bins is required. This allows use of the second bin while the top layers of the first bin are still composting.

10. Secondary composting volume may be provided in bins that are duplicates of the primary bins, or may be provided in one bin equal to the total required secondary volume.

11. It may be desirable to add one or two extra primary composting bins in a composter design. These bins can be used to store ingredients such as litter, sawdust, etc. If unusually high mortalities occur during some period, the extra bins could be put into service to compost the extra mortalities. Experience has shown that some ingredient storage at the composter site greatly facilitates management of the process.

While some producers find that they can manage with less capacity, the extra space is inexpensive. It provides valuable operating flexibility for contingencies such as short periods of higher than average mortality, busy times of the year when bins cannot be emptied on time, or occasional batches requiring additional time to decompose completely.

Total bin volume recommendations suggested here are based on average daily death losses. Catastrophic losses due to disease, ventilation failures, or other unpredictable events would require considerably larger facilities.

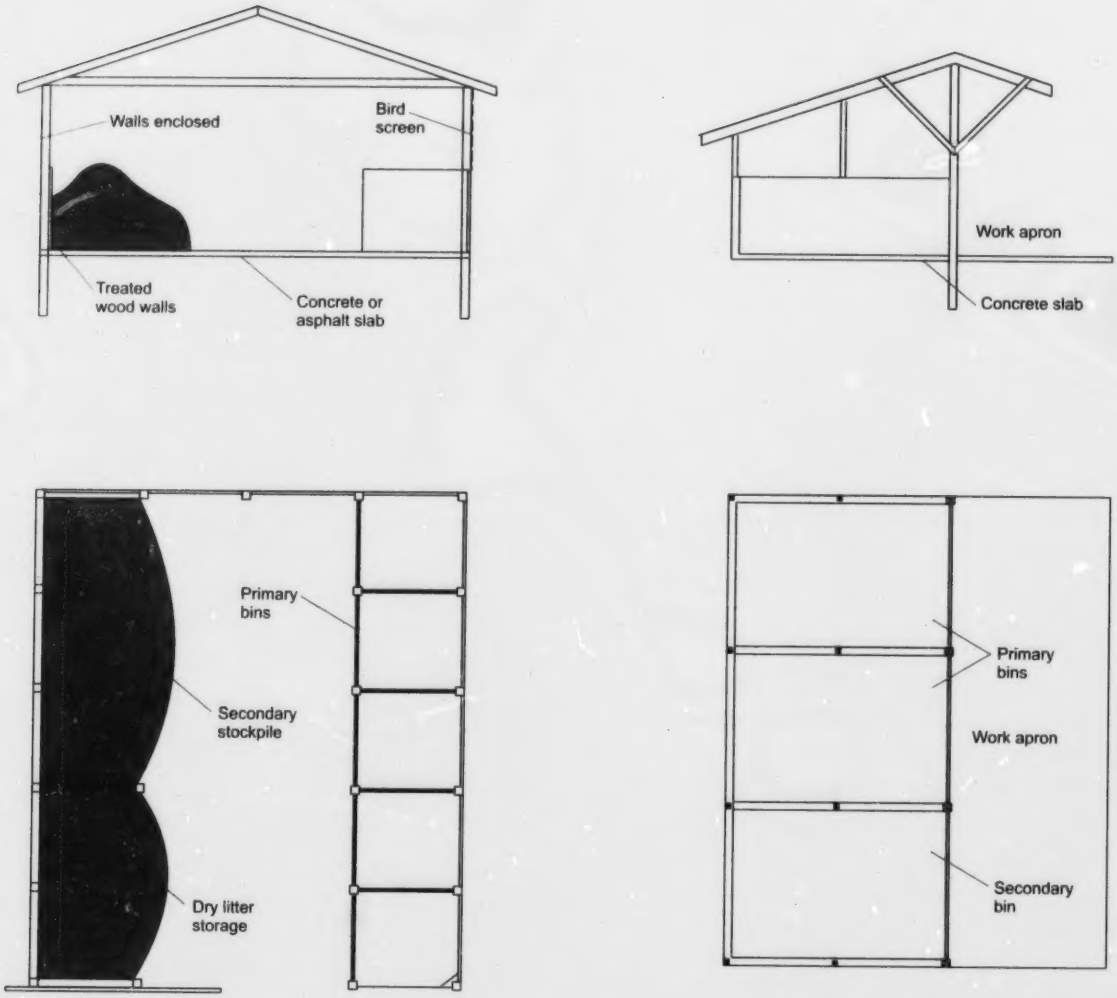
The number of bins required for a composting system depends upon the individual bin dimensions and the total required bin volume. Bins with 15 - 30 m^3 (530 - 1060 ft^3) of capacity are recommended for large carcasses. These bins have a floor area of approximately 10 - 20 m^2 (108 - 216 ft^2). Extremely large bins that take a long time to fill are undesirable as they lead to unnecessarily long heating times since the first carcasses were placed.

A minimum of three months composting time is needed in both the primary and secondary phases. It may be necessary to extend this period of time if an unusual number of large carcasses are composted, or if ambient temperatures are low. In most cases, a minimum of three bins will be required: two for primary composting and the third for secondary composting.

In a typical scenario, the first bin is filled with three months of death losses, at which time the second bin is started. At the end of the second three-month period, the second bin is full, and the last carcasses placed in the first bin have composted for three months. The contents of the first bin are then ready to move to the third bin for the secondary composting phase. After three months of secondary composting, the material can be moved out and applied to land, and the secondary bin (the third one) is available to receive contents of the second bin. Larger operations will require more than the minimum three bins. Experience has also shown that having extra bins available for storing fresh sawdust and finished compost is beneficial.

Figure 4 - Layout A is a schematic of a composter layout using five primary bins and a large floor area for stockpiling the secondary compost. It also includes space for dry litter. This building can be enclosed on three sides (one end door) and the wall above the primary bins can be screened. These added features improve visual aesthetics, reduce odours, and restrict bird access for better disease control.

Figure 4 - Layout B is a schematic of a composter layout using two primary bins and one secondary bin. The bins are enclosed on three sides. The work apron provides easy accessibility to each of the bins.



Layout A
Composting bins and stockpiling with central work area.

Layout B
Composting bins in open front shed.

Figure 4. Typical composting unit layouts.

Windrow Composter Design

The initial cost and management requirements for windrows differ from bin composting. Initial costs should be less than bin composting, but the management requirements are much more intense. Windrows are not sheltered from wind, rain, and snow which can affect the composting process. They require a constructed pad on which the windrows are built. Windrow composting can be used for the secondary stage (which lasts for 90 days) and begins once the material in the bin has been moved to the windrow site which mixes and aerates the compost.

Facilities accepting 20,000 tonnes of waste per year or less must follow the *Code of Practice for Compost Facilities.* Facilities accepting more than 20,000 tonnes of waste per year require an approval. Consult the *Activities Designation Regulation (A.R. 211/96)* to determine if an approval is required.

Some important points for site preparation and operation of windrows are as follows.

1. A composting pad with a 2% slope must be constructed on 0.5 m of clay with a permeability less than 5×10^{-8} m/s, or an alternative with equivalent protection.

2. The site requires a run-on control system to prevent surface water flowing onto the storage, processing, and curing areas.

3. The site requires a runoff control system to protect surface water and groundwater from contamination.

4. An air pollution control system to minimize offensive odours, airborne microbials, and airborne particulates so that the opacity does not exceed 40% over a period of 6 consecutive minutes per hour.

For further information on windrow design, see **Worksheet #3 in Appendix A.**

A complete copy of the *Code of Practice for Composting Facilities* is available at the following website, or by contacting any of the numbers listed below:

www.gov.ab.ca/qp/ascii/codes/compost.txt

Alberta Environmental Protection Contacts:
Northeast Boreal & Parkland Regions
Phone: (780) 427-9562
Northwest Boreal & Northern East Slopes Regions
Phone: (780) 723-8395
Southern East Slopes & Prairie Region
Phone: (403) 297-7605

Chapter 4 COMPOST PRODUCTION MANAGEMENT

Ingredient Selection

Sawdust is an ideal carbon source for swine mortality composting due to its small particle size, ease of handling, absorbency, and high carbon content. It also works well as a biofilter, allowing high temperatures to be achieved and sustained, and promotes bone decomposition when composting larger carcasses. Sawdust works well for outdoor windrows because of its ability to shed rain water. Straw is not recommended as a carbon source for swine composting. The use of straw can result in low temperatures, fluid leaching from the bins, and an extended processing time.

The weight and volume of the mortalities will determine the volume of sawdust required. A C:N ratio higher than 25:1 is satisfactory. In some cases, supplemental nitrogen may be required. Ammonium nitrate is a good source of nitrogen and can be mixed with the sawdust as it is added to the bin.

If using sawdust as the carbon source, approximately 6.25 m^3 (220 ft^3) is required per 1000 kg (2200 lb) of carcasses. If ammonium nitrate in a dry granular form is used to increase the nitrogen, about 3 kg (6.6 lb) is needed per 100 kg (220 lb) of carcass. Most composting is accomplished without the use of additional nitrogen, but it may help in starting up a new composting cycle and obtaining desired composting temperatures.

The size of sawdust used in composting creates the pore structure which influences the success of the operation. Although a fine or small particle size sawdust is not necessary, large wood chips and shavings do not seem to work as well. Sawdust or wood refuse material generated from bark and/or mulching operations may contain rocks, stones, and other foreign material in addition to excessively large wood particles, which are not suitable for composting.

There are certain procedures that are necessary to ensure that the composting process proceeds efficiently. The following steps should produce acceptable, finished compost for a swine operation utilizing a composter bin with a roof. ***Figure 5*** illustrates how to build a composting pile.

1. Start a primary composting bin by placing at least 300 mm (12 in) of sawdust under and around the first carcasses. It is very important to use a sufficient amount of sawdust so each carcass is covered on all sides with a minimum of 300 mm (12 in) of sawdust. Small pigs may be grouped or placed with somewhat less sawdust between them. Carcasses placed directly on dirt, concrete floors, or against bin walls will not compost properly.

2. Place carcasses at least 230 mm (9 in) from bin walls (300 mm from windrow edges). Cover each layer of carcasses with 150 mm (6 in) of sawdust before adding the next layer of mortalities. A final sawdust cover of 300 mm (12 in) placed over the final layer of mortalities minimizes odours and rodent problems. Hoofs, legs, ears, or snouts should never be left sticking out of the pile. Most problems in swine composting arise when insufficient sawdust is used as a top cover. Use a pointed rod or dowel to measure the thickness of the cover. After a day or two, large carcasses may need to be recovered as sawdust settles. The compost pile should be roofed.

Carcasses placed in warm sawdust begin composting more quickly. This can be accomplished by placing more than the minimum 300 mm (12 in) sawdust cover over the previous carcasses. This allows the sawdust to heat up so that successive carcasses are then buried in this pre-warmed sawdust. A loader bucket can be used to dig out a cavity in the pre-warmed sawdust before a fresh carcass is placed. If finished compost is available, it should be used to cover the carcass to provide additional heat and bacteria to initiate the composting process. Finally, fresh sawdust should be used to provide the top cover thickness needed for a new cavity for the next carcass.

3. Monitor the temperature of the composting pile with a long-stem, dial-type thermometer. When composting is proceeding properly, the temperature will reach 55 - 70°C (131 - 158°F). Primary bins started during cold weather may not begin composting immediately. However, if carcasses are buried with the proper amounts of sawdust, composting should begin on its own. There is usually enough heat in active, as opposed to newly started, compost piles to continue composting through cold weather. The insulation characteristics of sawdust are sufficient to minimize the effects of cold ambient temperatures.

   Although experience shows that temperatures above 75°C (167°F) are rare, a remote possibility exists that temperatures could rise to spontaneous combustion levels. If temperatures appear to be rising towards the 75°C (167°F) level at a constant or increasing rate, the compost should be removed from the bin and spread on the ground to cool.

4. After the last carcasses placed in the primary bin have composted for three months or longer, move the contents to a secondary bin for an additional three months. Moving the pile mixes and adds air while rebuilding a pore structure.

5. After the pile has composted another three months in a secondary bin, it should appear as a dark, granular, nearly black, humus-like material with very little odour. Some resistant parts such as teeth may still be identifiable, but should be soft and easily crumbled.

6. Use the finished compost (referenced above) for "starter" material on new carcasses being composted in primary bins. This provides heat and bacteria to enhance startup of the composting process. Experience has shown that up to 50% of the sawdust requirement for composting can be met using recycled finished compost. However, plan to use fresh sawdust in the amounts described for starting up a new composting operation until enough finished compost becomes available. Haul and spread finished compost as needed, using a conventional manure spreader. Apply the finished compost at the required agronomic rates for the crop being grown. For precise fertilizer content, obtain a laboratory analysis of the compost for nitrogen, phosphate, and potash.

7. Keep fresh sawdust as dry as possible to encourage a better composting process. In wet environments, sawdust piles should be covered to maximize dryness and minimize the generation of leachate. Fresh sawdust in a pile will shed some water if the pile is mounded and has no pockets or depressions.

8. Keep the area around the composter mowed and free of tall weeds and brush. Watch for any leaching that might occur. Using more sawdust in the bottom of the bins can help eliminate leaching problems.

Figure 5 illustrates mortality placement in layers in a composting bin.

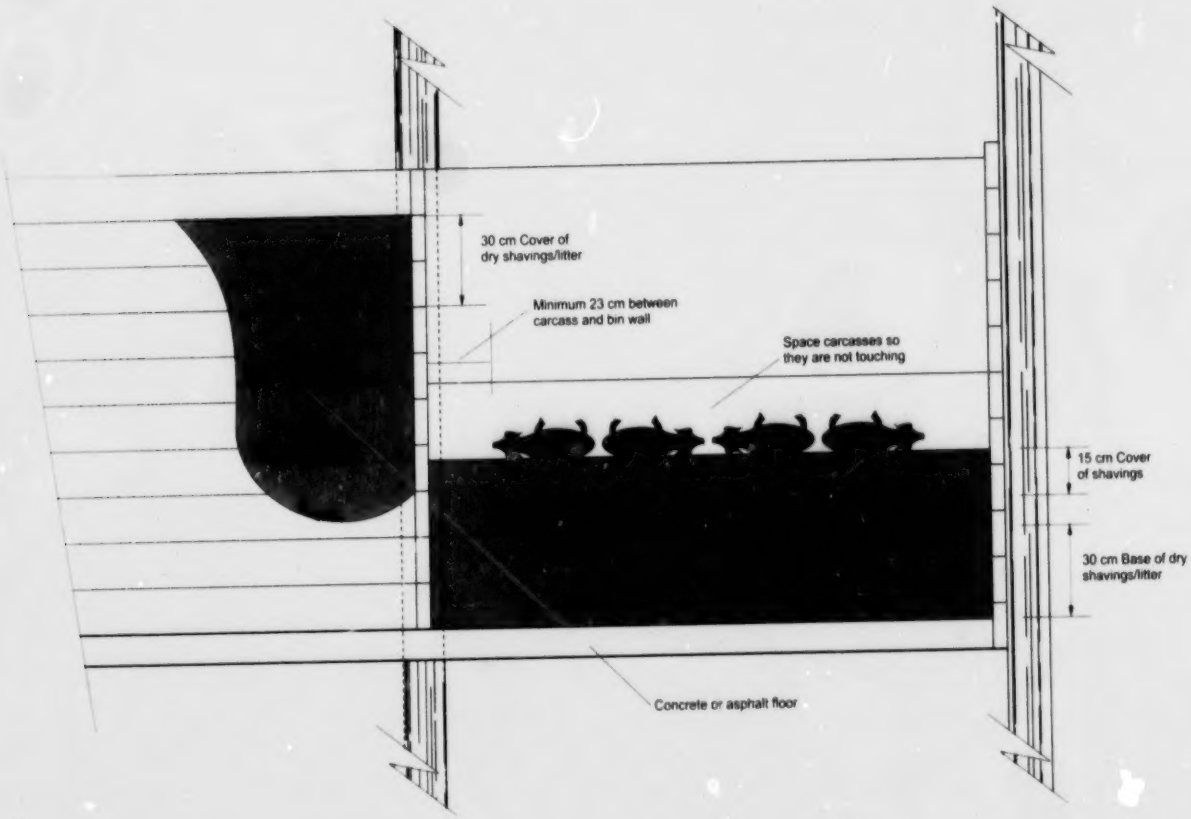


Figure 5. Composting bins loaded in layers.

Appendix A COMPOSTER DESIGN WORKSHEETS

Design Process

To assist you in determining yearly losses, sawdust requirements, number and size of bins, and windrow volume, refer to the following worksheets. Use the example worksheets as a guide for filling out your own worksheets.
Appendix B contains the regulations for composting mortalities from the *Destruction and Disposal of Dead Animals Regulation* under the *Livestock Diseases Act.*

Step 1: Use Worksheet #1 for calculating the the average daily death loss and annual sawdust requirements.

Step 2: Use Worksheet #2 to determine the bin size and number of bins required for the composting facilities.

Step 3: Use Worksheet #3 to determine windrow dimensions and the size of composting pad required.

Worksheet #1

Swine Loss and Sawdust Calculations

Annual Pig Production

1. _____ (# sows) x _____ (litters/yr) x _____ (pigs/litter (inc. stillborns)) = _____ pigs born/yr

2. _____ (pigs born/yr) - (_____ (pigs born/yr) x _____ /100 (% pre-weaning loss)) = _____ weaner pigs/yr

3. _____ (weaner pigs/yr) - (_____ (weaner pigs/yr) x _____ /100 (% weaning loss)) = _____ grower/finisher pigs/yr

4. _____ (grower/finisher pigs/yr) - (_____ (grower/finisher pigs/yr) x _____ /100 (% grower /finisher loss)) = _____ finished hogs/yr

Death Loss Material to be Handled

a. Sow/Boar Losses

_____ (# sows/boars) x _____ lbs (Avg. Wt.) x _____ /100 (% sow/boar loss) = _____ lbs loss/yr

b. Pre-weaner losses (including stillborns)

_____ (pigs born/yr) x _____ lbs (Avg. Wt.) x _____ /100 (% loss pre-weaning) = _____ lbs loss/yr

c. Weaner losses

_____ (weaner pigs/yr) x _____ lbs (Avg. Wt.) x _____ /100 (% weaner loss) = _____ lbs loss/yr

d. Grower/finisher losses

_____ (grower/finisher pigs/yr) x _____ lbs (Avg. Wt.) x _____ /100 (% grower/finisher loss) = _____ lbs loss/yr

Total Death Loss (add up group losses) = _____ lbs loss/yr

Average Daily Death Loss

_____ lbs/yr (total death loss) ÷ 365 = _____ lbs loss/day

Annual Sawdust Requirements

_____ lbs loss/yr (total death loss) x 0.0037 = _____ cu yards/yr

Note: Up to 50% of the sawdust can be replaced by finished compost

Conversion

_____ cu yards/yr (sawdust requirements) x 0.7645 = _____ cu metres/yr

Worksheet #1 - Example

Example: Swine Loss and Sawdust Calculations

200 Sow Farrow to Finish Operation

Annual Pig Production

1. 200 (# sows) x 2.3 (litters/yr) x 13.0 (pigs/litter (inc. stillborns)) = 5980 pigs born/yr

2. 5980 (pigs born/yr) - (5980 (pigs born/yr) x 19/100 (% pre-weaning loss)) = 4844 weaner pigs/yr

3. 4844 (weaner pigs/yr) - (4844 (weaner pigs/yr) x 2.6/100 (% weaning loss)) = 4718 grower/finisher pigs/yr

4. 4718 (grower/finisher pigs/yr) - (4718 (grower/finisher pigs/yr) x 4.2/100 (% grower /finisher loss)) = 4520 finished hogs/yr

Death Loss Material to be Handled

a. Sow/Boar Losses

200 (# sows/boars) x 440 lbs (Avg. Wt.) x 5.5/100 (% sow/boar loss) = 4840 lbs loss/yr

b. Pre-weaner losses (including stillborns)

5980 (pigs born/yr) x 4.4 lbs (Avg. Wt.) x 19/100 (% loss pre-weaning) = 4999.3 lbs loss/yr

c. Weaner losses

4844 (weaner pigs/yr) x 28.7 lbs (Avg. Wt.) x 2.6/100 (% weaner loss) = 3614.6 lbs loss/yr

d. Grower/finisher losses

4718 (grower/finisher pigs/yr) x 147 lbs (Avg. Wt.) x 4.2/100 (% grower/finisher loss) = 29128.9 lbs loss/yr

Total Death Loss (add up group losses) = 42582.8 lbs loss/yr

Average Daily Death Loss

42582.8 lbs/yr (total death loss) ÷ 365 = 116.7 lbs loss/day

Annual Sawdust Requirements

42582.8 lbs loss/yr (total death loss) x 0.0037 = 157.56 cu yards/yr

Note: Up to 50% of the sawdust can be replaced by finished compost

Conversion

157.56 cu yards/yr (sawdust requirements) x 0.7645 = 120.5 cu metres/yr

Worksheet #2

Bin Design and Selection for Swine

Bin Volumes

Primary Bin Volume = _____ (lbs death loss/day) x _____ = _____ cubic feet

Secondary Bin Volume = Primary Bin Volume = _____ cubic feet

Bin Wall Height

Bin Wall Height = _____ feet

Floor Areas

Primary Bin Floor Area = _____ cu. ft. ÷ _____ ft. = _____ sq. ft.

Secondary Bin Floor Area = Primary Bin Floor Area = _____ sq. ft.

Select Bin Size

Typical Bin Dimensions:

10 ft. x 10 ft.	10 ft. x 12 ft.	10 ft. x 14 ft.	10 ft. x 16 ft.
	12 ft. x 12 ft.	12 ft. x 14 ft.	12 ft. x 16 ft.

The bin area you choose should fall between 100 and 200 sq. ft.

Number of Primary Bins

of Primary Bins = _____ sq. ft. ÷ _____ sq. ft. = _____ Bins

Be sure to round up to the next whole number

Number of Secondary Bins

of Secondary Bins = # of Primary Bins = _____ Bins

Alternatively, 1 secondary bin can be used for every 2 primary bins if finished compost is utilized every 90 days (i.e. finished compost is not stored in bins).

Total Number of Bins

of Bins = _____ (# of Primary Bins) + _____ (# of Secondary Bins) + _____ (# of Additional Bins) = _____ Bins

Additional bins can be used for storage of finished compost, sawdust, etc.

Worksheet #2 - Example

Example: Bin Design and Selection for Swine
200 Sow Farrow to Finish Operation

Bin Volumes

Primary Bin Volume = 116.7 lbs death loss/day x 20 = 2334 cubic feet

Secondary Bin Volume = Primary Bin Volume = 2334 cubic feet

Bin Wall Height

Bin Wall Height = 5 feet

Floor Areas

Primary Bin Floor Area = 2334 cu. ft. ÷ 5 ft. = 466.8 sq. ft.

Secondary Bin Floor Area = Primary Bin Floor Area = 466.8 sq. ft.

Select Bin Size

Typical Bin Dimensions: 10 ft. x 10 ft. | 10 ft. x 12 ft. | 12 ft. x 12 ft. | (10 ft. x 14 ft.) | 12 ft. x 14 ft. | 10 ft. x 16 ft. | 12 ft. x 16 ft.

The bin area you choose should fall between 100 and 200 sq. ft.

Number of Primary Bins

# of Primary Bins = 466.8 sq. ft. ÷ 140 sq. ft. = 3.33 or 4 Bins

Be sure to round up to the next whole number

Number of Secondary Bins

# of Secondary Bins = # of Primary Bins = 4 Bins

Alternatively, 1 secondary bin can be used for every 2 primary bins if finished compost is utilized every 90 days (i.e. finished compost is not stored in bins).

Total Number of Bins

# of Bins = 4 (# of Primary Bins) + 4 (# of Secondary Bins) + 2 (# of Additional Bins) = 10 Bins

Additional bins can be used for storage of finished compost, sawdust, etc.

Worksheet #3

Windrow and Pad Sizing

Windrow Volume

Primary Windrow Volume = _____ (lbs loss/day) x _____ = _____ cubic feet

Secondary Windrow Volume = Primary Windrow Volume = _____ cubic feet

Windrow Height

Windrow Height = _____ feet A tall windrow generally makes better use of the pad area and sawdust. (5 to 7 feet work best)

Windrow Cross Section

Select the primary cross section from the table below based on the windrow height.

Windrow Height (ft.)	Windrow Cross Section (sq. ft.)
5	30
6	42
7	56

Secondary Windrow Cross Section = Primary Windrow Cross Section

Select Bin Size

Primary Windrow Length = _____ cu. ft (Primary Windrow Volume) ÷ _____ sq. ft. (Primary Windrow Cross Section Area) = _____ ft. (nearest)

If the windrow length is less than twice the windrow height, you do not have enough volume to readily achieve the desired windrow height. Reduce the windrow height and go back to Step 2.

Secondary Windrow Length = Primary Windrow Length

Dimensions of Composting Pad

Pad Length = _____ ft. + _____ ft. = _____ ft.

Select the pad width from the following table

Windrow Height (ft.)	Windrow Width (ft.)	Pad Width (ft)
5	11	52
6	13	56
7	15	60

Worksheet #3 - Example

Windrow and Pad Sizing

Windrow Volume

Primary Windrow Volume = 116.7 lbs loss/day x 20 = 2334 cubic feet

Secondary Windrow Volume = Primary Windrow Volume = 2334 cubic feet

Windrow Height

Windrow Height = 7 feet

A tall windrow generally makes better use of the pad area and sawdust. (5 to 7 feet work best)

Windrow Cross Section

Select the primary cross section from the table below based on the windrow height.

Windrow Height (ft.)	Windrow Cross Section (sq. ft.)
5	30
6	42
7	56

Secondary Windrow Cross Section = Primary Windrow Cross Section

Select Bin Size

Primary Windrow Length = 2334 cu. ft (Primary Windrow Volume) ÷ 56 sq. ft. (Primary Windrow Cross Section Area) = 41.7 or 42 ft (nearest)

If the windrow length is less than twice the windrow height, you do not have enough volume to readily achieve the desired windrow height. Reduce the windrow height and go back to Step 2.

Secondary Windrow Length = Primary Windrow Length

Dimensions of Composting Pad

Pad Length = 42 ft. + 10 ft. = 52 ft

Select the pad width from the following table

Windrow Height (ft.)	Windrow Width (ft.)	Pad Width (ft)
5	11	52
6	13	56
7	15	60

Appendix B ACTS AND REGULATIONS

Livestock Diseases Act: Destruction and Disposal of Dead Animals Regulation

Method of Disposal

2 (4)

(d) composting

(i) in a Class 1 compost facility as defined in the Waste Control Regulation (AR 192/96) that is designed, constructed and operated in accordance with sections 6 and 7 of the Code of Practice for Compost Facilities, published by the Department of Environment, or

(ii) subject to subsection (5), in a farm open compost pile that is

(A) located at least 100 metres from wells or other domestic water intakes, streams, creeks, ponds, springs and high water marks of lakes and at least 25 metres from the edge of a coulee, major cut or embankment,

(B) located at least 100 metres from any residences,

(C) designed in a manner that will exclude scavengers, and

(D) at least 100 metres from any livestock facilities, including pastures, situated on land owned or leased by another person,

References

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